Off-Channel Experimental Reconnection Project – 2019-2021

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OBJECTIVES

Focal goals of the Aquatic Species Restoration Plan (ASRP) and the associated Monitoring and Adaptive Management Plan (M&AM) are to restore impaired ecosystem processes and protect high functioning areas. This will be achieved, in part, through restoration actions to improve floodplain wetland and off-channel habitat connectivity. Improved watershed connectivity is expected to increase water storage and exchange, reducing water temperatures and diversifying fish and wildlife habitat. The Off-Channel Experimental Reconnection Project will inform the ASRP by helping answer the question: will increasing the level of connection between the mainstem river and an off-channel area affect flow and stage sufficiently to contract the seasonal thermal profile (disrupt thermocline) and improve the seasonal oxygen profile? A secondary objective is to answer the question: how does the increased level of off-channel connection influence native and exotic aquatic and semi-aquatic species richness and densities?

This project is a BACI (before-after control-impact) design study. We will enhance the connection between the mainstem and off-channel areas at two treatment sites. In addition to monitoring conditions pre- and post-treatment at these sites, we will also monitor the same conditions at two unmanipulated reference sites over the same time frame. One reference site will be isolated and have no hydrologic connection except potentially during extreme events. The other reference site will have yearly connection below flood stages. Each site will have at least two years of pre-treatment and two years of post-treatment monitoring, allowing us to account for natural environmental variability in our treatment response. We will evaluate the response in water quality, water elevation, native and exotic aquatic and semi-aquatic species, and habitat conditions. The longer-term response to reconnection is of interest and the biotic response may take years to manifest, so additional post-treatment monitoring may be conducted beyond the currently planned two years. Work in the 19-21 biennium included site selection, pre-treatment monitoring at candidate sites, and preliminary reconnection design for one site. During the 21-23 biennium we will finalize site selection, pre-treatment monitoring, and design and permitting. We anticipate applying reconnection treatments in summer 2023.

SURVEY APPROACH

Site Selection

During our previous work in 2015-2017 we surveyed 187 off-channel habitats in the mainstem Lower Chehalis River floodplain. We divided the floodplain into ten river segments based on junctions with major tributaries (**Figure 1**) and identified aquatic and semi-aquatic species richness for each river segment. Since one of our objectives is to monitor responses of exotic species, we originally confined our area for site selection to those with the highest exotic diversity, which was between the Black and Satsop Rivers (Hayes et al. 2020). Furthermore, we avoided tidally influenced areas because species diversity can be more varied in brackish water and reconnection durations can fluctuate daily rather than over longer timescales in entirely freshwater systems. Based on these criteria, we initially focused site selection from the Black River (RM 47) to Elma (RM 27) near Porter Creek. We later expanded this to

include sites up to the Skookumchuck River as there were willing landowners and suitable sites located slightly further up the river.

We used GIS to identify sites within the defined study area that could reasonably receive a reconnection treatment or act as a reference site. All potential sites needed to be safely accessible, perennial, and naturally occurring (i.e., not human constructed). For consideration as a reconnection treatment, a site could not be near roads or other infrastructure that may risk damage by the treatment. Due to the intensity of the proposed monitoring effort and the potential impacts of the treatment itself, landowner willingness is a significant factor that we had to account for during site selection.

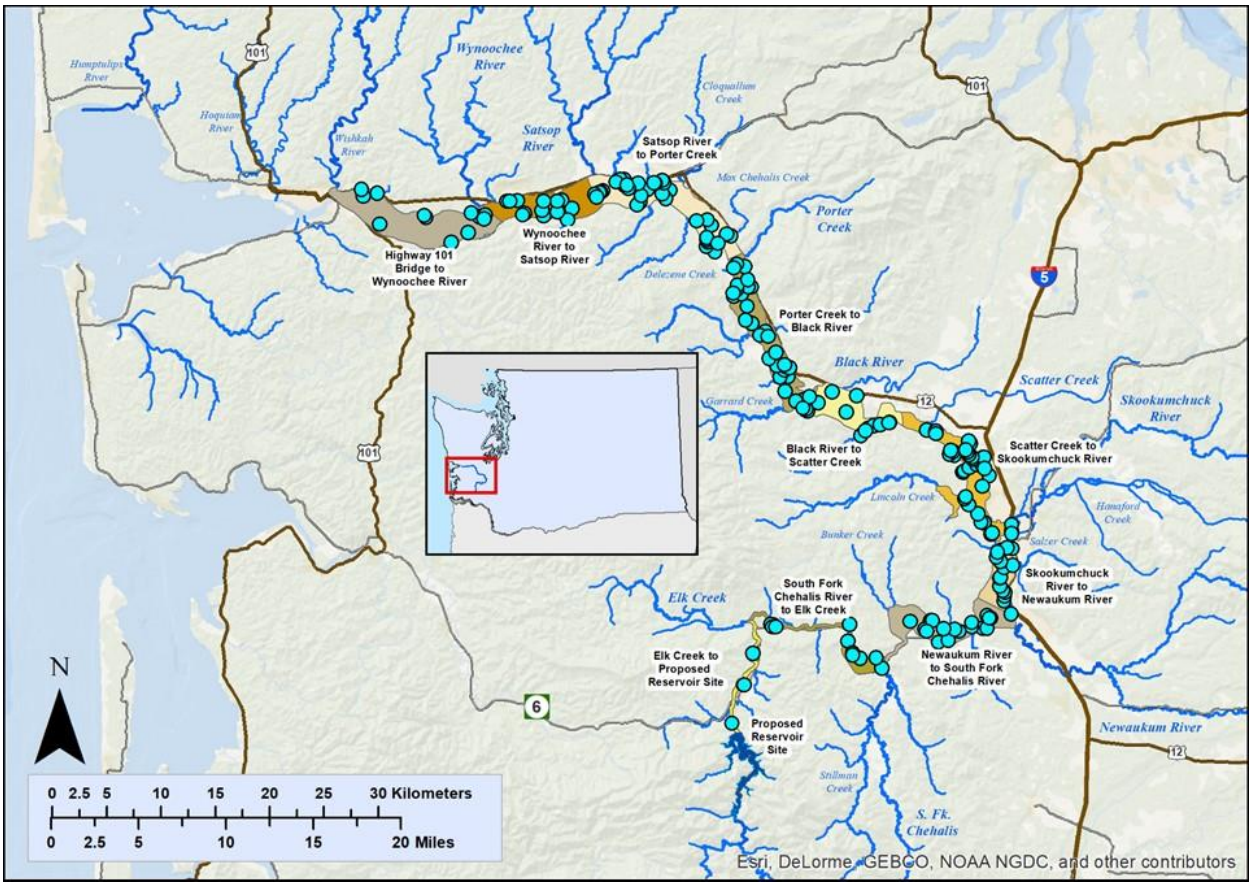

Figure 1*. Location of ten Chehalis River segments identified as reaches between junctions with major tributaries. Segments have a unique color and ID. Turquoise dots identify the locations of the 187 off-channel areas surveyed for aquatic and semi-aquatic species richness in the mainstem Lower Chehalis River floodplain from 2015-2017.*

Once potential sites were identified using GIS, we approached landowners to obtain permission to conduct preliminary site visits. Site visits focused on collecting information we cannot gather remotely with GIS, including strength of river connection, depth, and aquatic and semi-aquatic species assemblage. We also used preexisting data from past studies when possible. We identified site selection criteria to aid with site selection and the pairing of treatment and reference sites (**Table 1**). Minimizing variability in site selection criteria allowed for a better comparison of potential treatment effects.

***Table 1**. Criteria for site selection and reference-treatment pairing of off-channel sites for potential inclusion in the Off-Channel Experimental Reconnection project.*

Criteria	**Measurement**
Proximity to River	Directly adjacent, or distance (m)
Directionality of Connection	Upstream, Downstream, None, Undetermined
Strength of Connection	Strong, Minimum, None, Undetermined
Influence of another Tributary	Yes/No
Surface Area & Season (NAIP or previous survey)	Minimum, Maximum, Season (summer/winter)
Depth & Season	Minimum, Maximum, Season (summer/winter)
Wetted Width & Season (NAIP or previous survey)	Minimum, Maximum, Season (summer/winter)
Species Diversity (if known)	Aquatic and semi-aquatic species present; Undetermined

Since changes in thermocline, dissolved oxygen, and aquatic diversity are responses of interest, we identified sites having similar directionality of river connection, summer depth and surface area, and aquatic and semi-aquatic species occurrence. Once we identified a pool of sites that met our site selection criteria, we conducted site visits and consult with hydrologists and engineers to assess the efficacy of floodplain reconnection. When consensus was reached on whether a site should be included in our narrowed pool of candidate sites, we evaluated landowner willingness to participate in a long-term restoration study, including their interest in including a site on their lands for reconnection treatment. When landowners were interested in participating but were not willing to consider treatment application on their property, we continued to consider their sites for inclusion as potential reference sites.

Sites Selected

To date we have selected the Hoxit site for one of our study locations that will receive reconnection restoration (**Figure 2**). This site is owned by both DFW and the Chehalis Tribe near River Mile 37 and was one of our intensively studied off-channel sites from 2016-2017. This site already has all the water monitoring stations setup and a wealth of baseline physical data to inform reconnection impacts.

***Figure 2**. Hoxit site for enhanced upstream reconnection*

In addition, we have selected the Sanders site as a reference site (**Figure 3**). This site was part of our off-channel work in 2017 and is near River Mile 47. We have comparatively less baseline data on site conditions compared to the Hoxit site but it is connected up and downstream each year during regular winter flows. This property is privately-owned and we are currently working on finalizing access agreements for this location.

***Figure 3**. Sanders site selected as a easily connected reference location*

We have also selected the Chehalis Howanut Corner site near the confluence of the Black River and Chehalis at River Mile 48 as our entirely disconnected reference site (**Figure 4**). This site was part of our off-channel work in 2015 and 2016 and has multiple years of existing survey data available. This property is owned by the Chehalis Tribe and a private landowner. We are currently working on finalizing access agreements for this location.

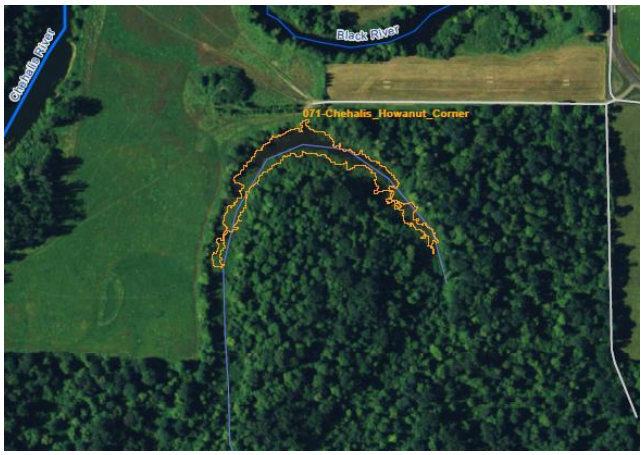

***Figure 4**. Chehalis Howanut Corner site selected as a disconnected reference location*

Final Site Selection

The remaining treatment site has yet to determined. Finalizing treatment sites was more complex than anticipated for multiple reasons. For instance, consultations with hydrologists and engineers highlighted challenges with selecting sites where response variables could be assessed in a reasonable timeframe

and for which the restoration action would not have to be regularly managed. Furthermore, other complicating factors like the prevalence of invasive Parrotfeather (*Myriophyllum aquaticum*) and whether some landowners would maintain ownership of their properties for the duration of the experiment complicated our decision making. We have narrowed down our final site selection to two locations and have site visits with hydrologists and engineers planned for early in the 21-23 biennium. We anticipate having site selection and access agreements finalized by the end of 2021.

Site Establishment

The study timeline includes two years of pre-treatment and at least two years of post-treatment data collection. Each study site will consist of the entire off-channel area and the adjacent mainstem river. To facilitate the measurement of biotic and habitat responses, we will establish ten permanent transects placed perpendicularly to the approximate center line along the length of each off-channel habitat (**Figure 5**). Transects will be equally spaced based on the summer aquatic footprint, and at least five meters apart. If a site is smaller than 50 meters in length, we will place as many transects as possible while maintaining our five-meter separation criterion. We will also install equipment for continuous monitoring at points throughout the study site.

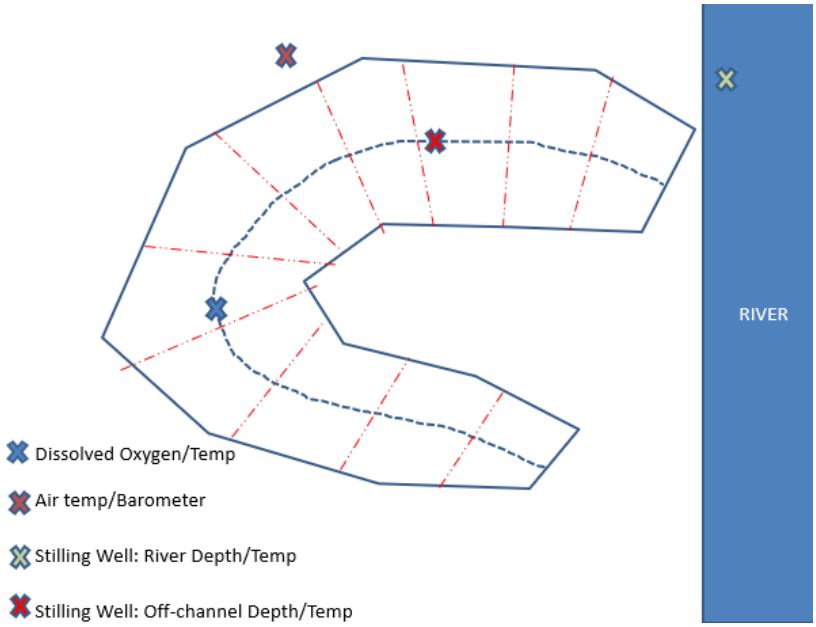

Figure 5*. Schematic of transects (red lines, n=10) in an off-channel study site (blue polygon) adjacent to the mainstem Chehalis River. Also shown are the placement of continuous hydrologic monitoring equipment.*

Preconstruction Design Surveys

XYZ Elevation Station Establishment and Engineering Surveys

WDFW Capital & Asset Management Program (CAMP) and WDFW Habitat Program – Restoration Division and Engineering Section

At the two reconnection treatment sites, WDFW will set permanent GPS elevation stations and conduct a topographical survey using a Total Station to collect site selective point data to develop a surface model to describe, define, and quantify the project site. Point data collected from the site defines a digital surface model which is used for hydrological modeling, and the development of project design and the creation of project plans and specifications.

Drone Flight Surveys (UAS)

WDFW Habitat Program, Science Division - Decision Analytics Section

At the treatment locations, drone flights will be conducted by an authorized individual with a FAA (Federal Aviation Administration) Remote Pilot Certificate to collect aerial photographs. The site will be scoped for access points, visible ground control target locations, and other site logistics. Ground control targets will be placed approximately 500' apart in a triangulated pattern. XYZ points will be collected at the center-point of each target using RTK GPS or Total Station. Repeat aerial photographs will be taken with at least 50% overlap at converging angles of the project site. Depending on the project size and shape, the patterns may change and several flights will likely be needed. Pilots will check all airspace regulations, flight, and weather advisories according to FAA regulations and adjust flight plans accordingly. Data gathered from drone flight surveys will be used to assist with engineering for design of the treatment and to compare pre-post construction conditions.

Monitoring Survey Design

Hydrologic Monitoring

WDFW Habitat Program, Science Division - Aquatic Research Section

We will conduct hydrologic monitoring continuously to understand the current seasonal hydrologic interaction between each off-channel study site area and the adjacent mainstem Chehalis River, and to evaluate any potential changes after reconnection. We will monitor water temperature, water elevation, air temperature and pressure, and dissolved oxygen (**Table 2**) at monumented points located throughout the study site (**Figure 2**). Installation procedures can be found in the QAPP for this project.

Aquatic Species Diversity Surveys

WDFW Habitat Program, Science Division - Aquatic Research Section

We will collect species occupancy and count data using two types of surveys (Egg Mass and Extensive), that incorporate a combination of sampling techniques focused on aquatic (i.e., fish) and semi-aquatic (i.e., amphibian) species. We will record species, life stage and method of capture of all individuals encountered. We will photograph at least one individual of each species and size class using a photo box with a scale to enable estimating body size.

Additionally, we will record incidental observations of birds, mammals and select invertebrate species (mussels & crayfish) seen using the off-channel area. For some species, such as beaver, we will also record signs (such as chews, lodges, runways, scat, scent mounts, etc.).

Table 2. *Hydrologic monitoring equipment installed, metrics monitored, number and distribution between off-channel (OC) and mainstem (MS) reaches and general placement of equipment in each study site. Exact details of placement location are in subsequent sections.*

Instrument	Metric	#/Site		Placement
		OC	MS	
Dissolved Oxygen Logger (PME DO2T)	Water Temp	2	0	Two located on water bottom (mudline) and two at the water surface
	Dissolved Oxygen	2	0	
Pressure-Temperature Transducer (Onset U-20-001-01)	Water Temp	2	1	Placed near mudline in stilling wells
	Water Elevation	2	1	
	Air Pressure	1	0	Placed on a south side of tree near OC
	Air Temp	1	0	
Temperature Logger (Onset UTBI-001 TidbiTv2)	Water Temp	2	0	Located at the water surface; tethered to pressure transducer stilling well on a float

Aquatic Species Diversity Sampling Techniques

Surveys Types

We conduct two different survey types at study sites: Egg Mass Surveys and Extensive Surveys. A combination of sampling techniques will be used to conduct these surveys (**Table 3**).

Table 3. *Survey types and sampling techniques used for each.*

Survey Type	Visual Encounter	Dip Netting	Trapping	Electrofishing
Egg Mass Survey	X	X		X
Extensive Survey	X	X	X	X

Egg Mass Surveys

The objective of the Egg Mass Survey is to detect egg masses and larval stages of amphibians, as well as fish. Egg Mass Surveys will be conducted three times each winter/spring (January-May). Each single day visit will be separated by approximately 30 days. During egg mass surveys we will use three sampling techniques: visual encounter surveys, dipnet sampling (50 dips), and backpack electrofishing *(see Sampling Techniques*).

Extensive Surveys

The main objective of this surveys is to detect fish and Bullfrogs which are not easily captured during the winter months using the techniques of the Egg Mass Surveys. Extensive Surveys take two days to complete and will be conducted twice each year, once in late June and once in late September. During Extensive Surveys we rely on trapping utilizing collapsible minnow traps and fyke nets (fish and turtle). At each site 30 collapsible minnow traps will be systematically distributed along each off-channel study site transect (3 traps/ transect) and left overnight (**Figure 5**). In addition to minnow traps, up to two Fyke nets (cat food baited) and two turtle traps (sardine baited) will be set overnight. The number of Fyke

traps will depend on the available habitat and will be set in waters up to 3 feet deep, using pipes or tied to trees to ensure traps remain open and functional.

During Extensive Surveys we will also conduct dipnet sampling (25 dips), visual encounter, and electrofishing surveys *(see Sampling Techniques)*. We will use a single pass electrofishing effort once during each site survey session (Reid et al. 2009). We will use a time-search approach, which is easily transferrable between sites and seasons, and more practical than a reach length-based approach based on the large amount of non-wadable habitat frequently encountered in off-channel areas. We have set the minimum total shock time/survey at 300 seconds which is recorded on the electrofisher, and a maximum total shock/processing time of 2 hours.

Pre-restoration data

Surveys started at the Hoxit restoration site October 1, 2019 and at the Sanders restoration site on October 12, 2020. Fall extensive surveys were the first to be done, followed by three egg mass surveys and a summer extensive survey. We grouped data by water year which extends from October-September.

The tables below show the presence and abundance of both native and non-native species found in both restoration sites pre-restoration. Four out of six native stillwater breeding amphibians have been documented at both sites; Long-Toed Salamander (*Ambystoma macrodactylum),* Northwestern Salamander (*Ambystome gracile),* Northern Red-Legged frog (*Rana aurora),* and Pacific Treefrog (*Psuedacris regilla)* (**Tables 4 & 5**). Bullfrogs (*Rana catesbeianus)*, a non-native species, was documented at both sites—though egg masses for Bullfrogs have not yet been found at either site. It should be noted that during egg mass surveys at the Sanders site, all egg masses were seen in a small ephemeral auxiliary pond located next to the main pond.

Six native fish species were documented at the sites, with Hoxit containing all six species and Sanders containing three of the six. These fish include Large Scale Sucker (*Catostomus macrocheilus)*, Northern Pikeminnow *(Ptychocheilus oregonensis)*, Redside Shiner (*Richardsonius balteatus)*, Speckled Dace *(Rhinichthys osculus)*, Three-spined Stickleback (*Gasterosteus aculeatus)*, and an unidentified Lamprey species (*Lampetra sp.)* (**Table 4 & 6**). Additionally, six species of non-native fish were also found at the two sites with Hoxit containing four of the six and Sanders containing five. Non-native fish species included: Bluegill (*Lepomis macrochirus)*, Brown Bullhead (*Ameiurus nebulosus)*, Common Carp (*Cyprinus carpio)*, Large Mouth Bass (*Micropterus salmoides)*, Rock Bass (*Ambloplites rupestris)*, and unidentified Centrarchids (**Table 4 & 6**).

Beaver activity has been recorded at the Hoxit site and the presence of grazing cattle was noted at the Sanders site. A Western-Painted Turtle (*Chrysemys picta belli)* was captured during an egg mass survey at the Hoxit restoration site in 2020. Though proper bird and waterfowl surveys have not been done at either site, we have taken notes on notable species using the ponds. Further data on the avifauna using the wetlands should be considered in order to create a comprehensive list of all species present at the sites pre-restoration.

Table 4. *Species Occurrence and Taxon Richness Summary at the Hoxit and Sanders Restoration Site in 2019-2021 Surveys. Surveys at the Hoxit site started in fall 2019 and fall 2020 at the Sanders site.*

Taxa		Species Occurrence and Richness	
		Hoxit	Sanders
Native Amphibians		4	4
Long-toed Salamander		X	X
Northwestern Salamander		X	X
Northern Red-legged Frog		X	X
Pacific Treefrog		X	X
Roughskin Newt		-	-
Western Toad		-	-
Non-Native Amphibians		1	1
American Bullfrog		X	X
Native Fish		6	3
Chum Salmon		-	-
Largescale Sucker		X	-
Northern Pikeminnow		X	X*
Olympic Mudminnow		-	-
Lamprey sp.		X	-
Prickly Sculpin		-	-
Rainbow/Steelhead Trout		-	-
Redside Shiner		X	X
Riffle/Reticulate Sculpin		-	-
Speckled Dace		X	-
Three-spined Stickleback		X	X
Non-Native Fish		4	5
Black Crappie		-	-
Bluegill		X	X
Brown Bullhead		-	X
Common Carp		-	X
Largemouth Bass		X	X
Pumpkinseed		-	-
Rock Bass		X	-
Yellow Perch		-	-
Unknown Centrarchid		X	X
Grand Totals	Native	10	7
	Non-Native	5	6
	Overall	**15**	**13**

*Fish was listed as a possible Pike minnow

Table 5. *Taxon Richness Summary for Amphibians at Hoxit and 182-Sanders Restoration Sites in 2019-2021 Surveys by Water Year (October-September). Sampling did not occur at 182-Sanders until October 2020.*

Taxa		Water Year	Species Occurrence and Richness	
			Hoxit	Sanders
Native Amphibians				
Long-toed Salamander		2019-2020	X	N/A
		2020-2021	X	X
Northwestern Salamander		2019-2020	X	N/A
		2020-2021	X	X
Northern Red-legged frog		2019-2020	X	N/A
		2020-2021	X	X
Pacific Treefrog		2019-2020	X	N/A
		2020-2021	X	X
Roughskin Newt		2019-2020	-	N/A
		2020-2021	-	-
Western Toad		2019-2020	-	N/A
		2020-2021	-	-
Non-Native Amphibians				
American Bullfrog		2019-2020	X	N/A
		2020-2021	X	X
Grand Totals	Native	2019-2020	4	N/A
		2020-2021	4	4
	Non-Native	2019-2020	1	N/A
		2020-2021	1	1
	Overall	2019-2020	5	N/A
		2020-2021	5	5

Table 6. *Species Occurrence and Taxon Richness Summary for Fish at the Hoxit and Sanders restoration sites from 2019-2021 Water Year (October-September). Sampling did not occur at Sanders until October 2020*

Taxa	Water Year	Species Occurrence and Richness	
		Hoxit	Sanders
Native Fish			
Chum salmon	2019-2020	-	N/A
	2020-2021	-	-
Largescale sucker	2019-2020	X	N/A
	2020-2021	X	-
Northern pikeminnow	2019-2020	X	N/A
	2020-2021	-	X*
Olympic mudminnow	2019-2020	-	N/A
	2020-2021	-	-
Pacific lamprey	2019-2020	X	N/A
	2020-2021	-	-
Sculpin spp.	2019-2020	**X**	N/A
	2020-2021	-	-
Rainbow/Steelhead trout	2019-2020	-	N/A
	2020-2021	-	-
Redside shiner	2019-2020	-	N/A
	2020-2021	-	-
Speckled dace	2019-2020	X	N/A
	2020-2021	-	-
Three Spine Stickleback	2019- 2020	-	N/A
	2020-2021	X	X
Red sided shiner	2019-2020	X	-
	2020-2021	-	X
Non-Native Fish			
Black Crappie	2019-2020	-	N/A
	2020-2021	-	-
Bluegill	2019-2020	X	N/A
	2020-2021	-	X
Brown Bullhead	2019-2020	X	N/A
	2020-2021	-	X
Common Carp	2019-2020	-	N/A
	2020-2021	-	X
Largemouth Bass	2019-2020	**X**	N/A
	2020-2021	-	**X**
Pumpkinseed	2019-2020	X	N/A
	2020-2021	-	X

Rock Bass		2019-2020	X	N/A
		2020-2021	X	-
Yellow Perch		2019-2020	-	N/A
		2020-2021	-	-
Unknown Centrachid		2019-2020	X	-
		2020-2021	X	X
Grand Totals	Native	2019-2020	6	N/A
		2020-2021	2	3
	Non-Native	2019-2020	6	N/A
		2020-2021	2	5
	Overall	2019-2020	12	N/A
		2020-2021	4	8

Photo points

Permanent photo points will be established with rebar/flagging and we will collect GPS points at a minimum of three locations distributed around the site to allow visualization of all parts of wetland. Photos will be taken quarterly every 30° for a full 360° view. Permanent photo points allow us to quantify changes that are occurring throughout the year and allow us to see changes in large woody debris (LWD) or windthrow more easily. Photos will be compared for both seasonal and pre- vs. post-construction variability (**Figure 6**).

Figure 6. *Example of seasonal photo point changes at the Hoxit restoration site.*

REFERENCES

Hayes, M., J. Tyson, and K. Douville. 2020. Chehalis ASRP Surveys in Floodplain Off-Channel Habitats. Report for Post-Feasibility Baseline, Draft Report, Washington Department of Fish and Wildlife, Habitat Program, Aquatic Research Section.